PATENT ABSTRACTS OF JAPAN

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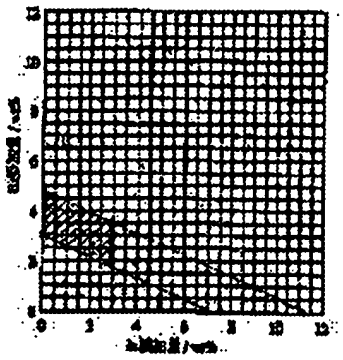
(71)Applicant : MITSUI MINING & SMELTING CO LTD
(72)Inventor : NINOMIYA RYUJI
MATSUNAGA JUNICHI

(54) LEAD FREE SOLDERING ALLOY

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain a soldering alloy to show the mechanical property equivalent to Pb-Sn soldering alloy, that is, ≥4.0kgf/mm2 tensile strength, ≥30% elongation without containing lead or cadmium causing environmental pollution.
SOLUTION: A lead free soldering alloy has a composition consisting of 6-10% Zn, <3% In and the quantity of Zn, Bi, In to satisfy A value of ≥21.00 in the next discriminating equation (I) and B value of ≤34.05 in the discriminating equation (II) and the balance Sn. A=[Znwt%]+5.00[Biwt%]+2.14[-Inwt%]...(I) B=[Znwt%] +5.89[Biwt%]+2.51[-Inwt%]...(II)



[0010]

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Notes:
1. Untranslatable words are replaced with asterisks (****).
2. Texts in the figures are not translated and shown as it is.

Translated: 07:02:49 JST 03/20/2006
Dictionary: Last updated 03/03/2006 / Priority: 1. Chemistry / 2. Mechanical engineering / 3. Architecture/Civil engineering

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FULL CONTENTS

[Claim(s)]
[Claim 1] Zn: The lead-free solder alloy which the value of A of the following discriminant (1) contains Bi and In below 3wt% 6 - 10wt% in 21.00 or more and the amount from which the value of B of a discriminant (2) becomes 34.05 or less, and consists of the remainder Sn.
A=[Znwt%]+5.00[Biwt%] +2.14 [Inwt%] -- (1) B=[Znwt%]+5.89[Biwt%]+2.51 [Inwt%] -- (2)

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the solder alloy of the **** inclusion which has the strength property of the solder alloy average which consists of conventional lead-tin.
[0002]
[Description of the Prior Art] As a solder alloy, the alloy near the eutectic composition of Pb-Sn is common knowledge as a typical thing conventionally. Or the alloy which consists of Zn-Cd which raised hardness rather than the eutectic solder of Pb-Sn again is known. However, as for the former solder, leaden hazardous property had become a problem, and the adverse effect to the operator of a cadmium steam etc. had become a problem, and the latter solder was that for which an environmental problem in recent years cannot be solved.
[0003]
[Problem to be solved by the invention] Then, the zinc and the tin system solder alloy which do not contain Pb or Cd harmful as a solder alloy etc. are proposed. For example, although there was a 3.5 Ag-Sn solder alloy, this solder alloy was what has the trouble that tensile strength is low, although

there was elongation. Thus, in the conventional lead-free solder alloy, about the same mechanical property as a Pb-Sn solder alloy does not come out. the grade which may be enough satisfied on the occasion of a solder activity with both actual mechanical properties especially tensile strength, and elongation values without including harmful Pb or harmful Cd etc. -- tensile strength is more specifically extended more than by 4.0 kgf(s)/mm2, and 30% or more of solder alloy is desired for the value.

[0004] Both this inventions aim at offering the solder alloy which was excellent just like [which was moreover excellent in the grade which trouble does not produce on the occasion of a actual solder activity which tensile strength and elongation mentioned above] the Pb-Sn solder alloy in view of the above-mentioned actual condition excluding harmful lead etc.

[0005]

[Means for solving problem] The solder alloy of this invention contains Bi and less than [In:3wt%] Zn:6 - 10wt%. In the value of B of 21.00 or more and a discriminant (2), the value of A of the following discriminant (1) contains these [Zn and Bi] and In in the amount which becomes 34.05 or less, and the lead-free solder alloy which consists of the remainder Sn attains said technical problem.

A=[Znwt%]+5.00[Biwt%]+2.14 [Inwt%] -- (1)

B=[Znwt%]+5.89[Biwt%]+2.51 [Inwt%] -- (2)

[0006]

[Mode for carrying out the invention] In order to have used Sn as the base and to carry out addition inclusion of the addition content of Zn, Bi, and In by this invention in the amount that the value of a discriminant (1) and A of (2), and B becomes 21.00 or more and 34.05 or less, respectively, Tensile strength is set more than to 4.0 kgf(s)/mm2, elongation becomes 30% or more, and the characteristics which were excellent just like [conventional] the Pb-Sn solder alloy are acquired.

[0007] this invention -- by being and making zinc contain, there is an effect of raising a heat-resisting property, a melting point falls further, and hardness becomes high. Although inclusion beyond 6wt% is appropriate for that purpose, if zinc content comes to exceed 8.8wt% so that clearly also from a tin-zinc binary-condition figure, a melting point will become high conversely, soldering temperature will become high, and since there is a danger of exerting breakage on electronic parts etc., a zincky maximum is made into 10wt%. Moreover, Bi and In in this invention are set on the basis of said Zn content. In order to extend the tensile strength which is the characteristics which excelled [this invention] in the Pb-Sn solder alloy average made into the object more than by 4.0 kgf(s)/mm2 and for a value to satisfy 30% or more, among 6 - 10wt% of amount within the limits of zincings 6wt% and 7wt% and 8wt%, It adjusts so that the content of Bi and In in 10wt% may enter in drawing 1 - the bias of drawing 5 9wt% (however, In = 0 removes). As shown the connection between these drawing 1 - drawing 5 in a discriminant (1) and (2), when it is expressed, in the value of A of a formula (1), the value of 21.00 or more and a discriminant (2) can show as 34.05 or less. That is, when the value of less than 21.00 and a discriminant (2) exceeds 34.05 in the value of a discriminant (1), 30% or more of value is no longer acquired [the target tensile strength] for elongation more than by 4.0 kgf

(s)/mm2 by this invention. These discriminants (1) express with a formula the straight line which shows the lower part border area of drawing 1 -5, and the straight line a discriminant (2) indicates the upper part border area of drawing 1 -5 to be.

[0008] In this invention alloy, In is an indispensable alloying element added in the amount below 3wt% as mentioned above. Namely, although In reduces the fusing point of an alloy like Bi [since the addition effect is / the In / larger compared with Bi in order to raise tensile strength and elongation as in this invention, in order for addition of In to attain the object in early stages of this invention alloy, are an indispensable element, but] Since In is especially expensive, a lot of addition should be avoided, and In may be less than [3wt%] from this meaning.

[0009] In the quarternary alloy of a Sn-Zn-Bi-In system concerning this invention, if a discriminant (1) and (2) are solved under 0<In<3wt% of a condition 6wt%<=Zn<=10wt%, Bi content will become 0.9 - 4.8 wt%.

[0010] The solder alloy concerning this invention can be made to contain elements added by the solder alloy well-known besides Zn, Bi, and In which were mentioned above, such as Ag, Au, Cu, and Sb, so that it may become an addition not more than 2.0wt% in total. These elements increase the flare nature of solder and Ag's increase the gloss after soldering, for example. Cu increases junction hardness, makes creep resistance increase a little, and has the operation which suppresses erosion of a copper chip further. Sb makes a soldering appearance good and also increases the increase of junction hardness, and creep resistance. Moreover, although Au is an impurity, if it is less than 2.5wt%, soldering nature is not spoiled but inclusion is permitted.

[0011] An example is shown below.

[0012]

[Working example] 10kg weighing capacity was carried out by AUW so that it might become the presentation which showed Sn, Zn, Bi, In, and Pb in the presentation table of Table 1, and it dissolved with the electric furnace in the air using the graphite crucible. The melting temperature was 300 degrees C, after each metal dissolves thoroughly, in order to lose gravity segregation, was fully agitated and was cast to the metal pattern with 150x60mm, a 150-mm-high inside dimension method, and a mold thickness of 10mm. From the lower part of the obtained casting, the JIS No. 4 specimen was extracted with machining, and tensile strength and an elongation value were measured with the test method according to JIS Z 2241. Those results are shown in Table 1. In addition, the characteristics of a Pb-Sn eutectic solder alloy and a 3.5 Ag-Sn solder alloy were also collectively shown in Table 1 for the comparison.

[0013]

[Table 1]

[0014] It was that in which 4.0 kgf(s)/more than mm2 is obtained for those mechanical strengths, 30% or more of value is acquired for an elongation value, and the solder alloy of this invention presentation range can attain an early technical problem from Table 1.

[0015]

[Effect of the Invention] According to above this inventions, the solder alloy which do not contain lead or cadmium etc. in which environmental pollution is caused, and it is carried out, and the mechanical property of the conventional Pb-Sn solder alloy average, i.e., tensile strength, shows 4.0 kgf(s)/more than mm2 to, and an elongation value can show 30% or more of value is obtained.

[Brief Description of the Drawings]

[Drawing 1] It is the related figure of the addition of In and Bi at the time of Zn:6wt% in the solder alloy concerning this invention (remainder Sn).

[Drawing 2] It is the related figure of the addition of In and Bi at the time of Zn:7wt% in the solder alloy concerning this invention (remainder Sn).

[Drawing 3] It is the related figure of the addition of In and Bi at the time of Zn:8wt% in the solder alloy concerning this invention (remainder Sn).

[Drawing 4] It is the related figure of the addition of In and Bi at the time of Zn:9wt% in the solder alloy concerning this invention (remainder Sn).

[Drawing 5] It is the related figure of the addition of In and Bi at the time of Zn:10wt% in the solder alloy concerning this invention (remainder Sn).

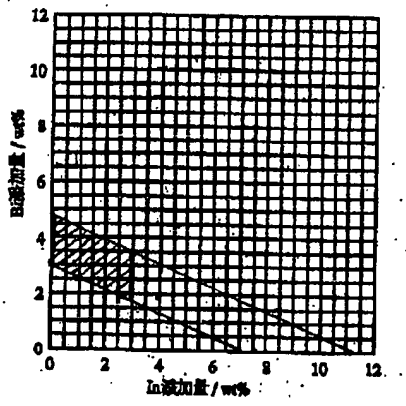
[Table 1]

	化学組成(wt%)				引張強度	伸び値
	Zn	In	Bi	Sn	(kgf/mm²)	(%)
実施例	6	0.1	3	91	4.00	36.5
	6	0.1	4	90	4.44	32.8
	6	1	3	90	4.19	34.9
	6	1	4	89	4.63	31.2
	6	2	3	89	4.37	33.3
	6	3	2	89	4.12	35.4
	6	3	3	88	4.56	31.8
	7	0.1	3	90	4.08	35.8
	7	0.1	4	89	4.51	32.2
	7	1	3	89	4.26	34.3
	7	1	4	88	4.70	30.6
	7	2	2	89	4.01	36.4
	7	2	3	88	4.45	32.7
	7	3	2	88	4.20	34.8
	7	3	3	87	4.64	31.1
	8	0.1	3	89	4.15	35.2
	8	0.1	4	88	4.59	31.6
	8	1	3	88	4.34	33.6
	8	1	4	87	4.77	30.0
	8	2	2	88	4.09	35.7
	8	2	3	87	4.52	32.1
	8	3	2	87	4.28	34.2
	8	3	3	86	4.71	30.5
	9	0.1	3	88	4.23	34.6
	9	0.1	4	87	4.66	30.9
	9	1	3	87	4.41	33.0
	9	2	2	87	4.17	35.1
	9	2	3	86	4.60	31.5
	9	3	2	86	4.35	33.5
	10	0.1	3	87	4.30	33.9
	10	0.1	4	86	4.73	30.3
	10	1	2	87	4.06	36.0
	10	1	3	86	4.49	32.4
	10	2	2	86	4.24	34.5
	10	2	3	85	4.67	30.9
	10	3	1	86	4.00	36.5
	10	3	2	85	4.42	32.9
比較例	6	0	2	92	3.56	40.2
	6	0	5	89	4.88	29.1
	6	1	2	91	3.75	38.6
	6	1	5	88	5.07	27.5
	6	2	2	90	3.94	37.0
	6	2	4	88	4.82	29.6
	6	3	1	90	3.69	39.1
	6	3	4	87	5.01	28.1

[Table 1]

	化学組成(wt%)				引張強度 (kgf/mm²)	伸び値 (%)
	Zn	In	Bi	Sn		
比	7	0	2	91	3.64	39.5
	7	0	5	88	4.96	28.5
	7	1	2	90	3.83	37.9
	7	1	5	87	5.14	26.9
	7	2	1	90	3.58	40.0
	7	2	4	87	4.89	29.0
	7	3	1	89	3.77	38.4
	7	3	4	86	5.08	27.5
	8	0	2	90	3.72	38.8
	8	0	5	87	5.03	27.9
較	8	1	2	89	3.91	37.3
	8	1	5	86	5.21	26.3
	8	2	1	89	3.66	39.3
	8	2	4	86	4.96	28.4
	8	3	1	88	3.85	37.8
	8	3	4	85	5.15	26.9
	9	0	2	89	3.80	38.2
例	9	0	5	86	5.10	27.3
	9	1	2	88	3.98	36.6
	9	1	4	86	4.85	29.4
	9	2	1	88	3.74	38.6
	9	2	4	85	5.03	27.9
	9	3	1	87	3.92	37.1
	9	3	3	85	4.78	29.9
	10	0	2	88	3.88	37.5
	10	0	5	85	5.16	26.7
	10	1	1	88	3.64	39.5
	10	1	4	85	4.92	28.8
	10	2	1	87	3.82	38.0
	10	2	4	84	5.10	27.3
	10	3	0	87	3.58	40.0
	10	3	3	84	4.85	29.4
	8.8	0	0	91.2	2.94	45.4
	Pb－63Sn				3.80	30.0
	Sn－3.5Ag				2.00	70.0

[Drawing 1]



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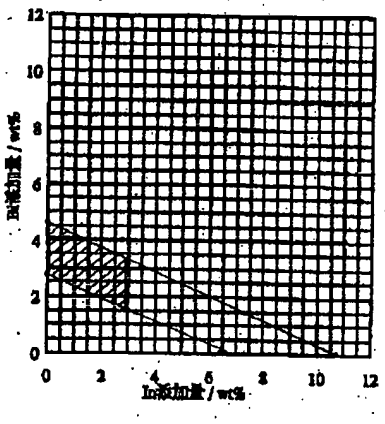

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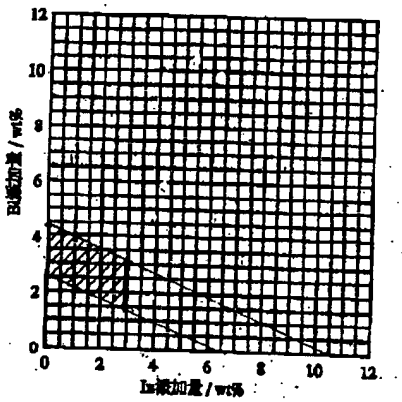

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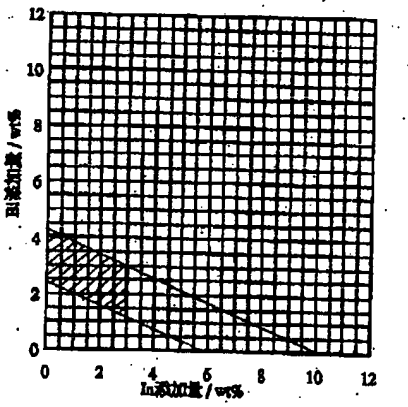

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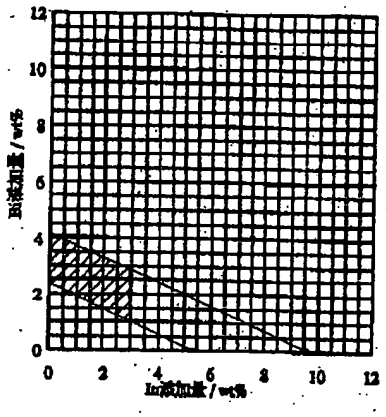

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